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SPECIFICATION FOR METAL PATTERN AND EPOXY RESIN PATTERN EQUIPMENTS FOR FOUNDRIES

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NEW DELHI 110002

Gr 7 *January* 1988

Indian Standard

SPECIFICATION FOR METAL PATTERN AND EPOXY RESIN PATTERN EQUIPMENTS FOR FOUNDRIES

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Indian Standard

SPECIFICATION FOR METAL PATTERN AND EPOXY RESIN PATTERN EQUIPMENTS FOR FOUNDRIES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 11 February 1987, after the draft finalized by the Foundry Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 While reviewing IS : 1513-1971*, in the light of the experience gained, the committee decided to limit the standard for wooden patterns only which has since been published as IS : 1513-1980†. Keeping this in view and the recent development in the foundry industry this separate Indian Standard specification has been formulated covering all the requirements of metal patterns and epoxy resin patterns.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960‡. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of pattern equipments for foundry. It specifies mould tapers, contraction allowances, machining allowances, pattern manufacturing tolerances and other technical aspects of pattern making and usages.

1.2 This standard does not cover pattern accessories, like guide pins, closing pins, vent, wires, which are covered by separate Indian Standards

*Specification for pattern equipment for foundries.
†Wooden pattern equipment for foundries (*second revision*).
‡Rules for rounding off numerical values (*revised*).

[*see* IS : 4981-1984*, IS : 4982-1984†, IS : 6447-1986‡] and guide bushes (*under preparation*), etc.

2. MATERIALS

2.1 Metal Patterns Core Boxes, Etc

2.1.1 *Grey Iron Castings* — Grey iron castings shall conform to grade FG 200 and FG 250 of IS : 210-1978§.

2.1.1.1 Heat resistant grey iron for core boxes.

2.1.2 *Spheroidal or Nodular Graphite Iron* — Spheroidal or nodular graphite iron shall conform to grade SG 410/18 of IS : 1865-1974||.

2.1.3 *Aluminium Castings* — Aluminium castings shall conform to grade 4600-M, 4250-M and 4250-W of IS : 617-1975¶.

2.1.4 *Steel Forgings* — Steel forgings shall conform to grade 35C8 or 45C8 of IS : 2004-1978**.

2.1.5 Steel sections conforming to IS : 226-1975††.

2.1.6 Brass castings designated as LCB1 conforming to IS : 292-1983‡‡.

2.1.7 Tin bronze castings conforming to IS : 306-1983§§. Leaded tin bronze to grade LTB2 conforming to IS : 318-1981||||.

2.1.8 Phosphor bronze castings conforming to IS : 28-1985¶¶.

2.2 Non-metal Patterns

2.2.1 *Epoxy Resin*

3. RULES FOR DESIGNING

3.1 Contraction Allowance — Due to varying foundry techniques the component design, etc, the contraction in castings may vary appreciably

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*Specification for guide pins for foundry pattern plates (*second revision*).

†Specification for closing pins for foundry moulding boxes (*second revision*).

‡Specification for vent wires for use in foundries (*first revision*).

§Specification for grey iron castings (*third revision*).

||Specification for iron castings with spheroidal or nodular graphite (*second revision*).

¶Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes (*second revision*).

**Specification for carbon steel forgings for general engineering purposes (*second revision*).

††Specification for structural steel (standard quality) (*fifth revision*).

‡‡Specification for leaded brass ingots and castings (*second revision*).

§§Specification for tin bronze ingots and castings (*third revision*).

||||Specification for leaded tin bronze ingots and castings (*second revision*).

¶¶Specification for phosphor bronze ingots and castings (*fourth revision*).

from that indicated by the normal contraction rules. Consequently it is strongly recommended that the purchaser should consult the foundry about the contraction allowance to be in the construction of the pattern. For guidance, contraction allowances which are in common use for linear dimensions have been given in Table 1.

TABLE 1 CONTRACTION ALLOWANCES ON PATTERNS

Sl No.	Cast Metal	Dimension mm	Contraction per Metre mm	Remarks
1.	Grey cast iron	Up to 600	10	
		Over 600	8	
2.	Nodular graphite iron	Up to 1 200	7	May vary according to method of moulding
		Over 1 200	6	
3.	White iron (malleable iron)	Up to 600	6	Up to 6 to 12 mm thick
		600 to 1 200	4-5	
		Over 1 200	0	For greater thickness values may be less, particularly in case of Pearlitic Malleable Iron
4.	Cast steel	Up to 300	20	
		300 to 600	18	
		600 to 1 200	16	
		1 200 to 1 800	14	
		Over 1 800	12	
5.	Aluminium	Up to 600	15	Less for cored construction
		600 to 1 200	13	
		1 200 to 1 800	12	
		Over 1 800	10	
6.	Magnesium	Up to 1 200	15	
		Over 1 200	13	
7.	Brass	—	15-16	
8.	Bronze and gun-metal	—	10-20	Varies with composition

Note — The actual solid contraction taking place shall depend on several factors such as:

i) Composition of metal, impurities nnd constituents.

ii) Method of moulding used, mould design, mould material and the resistance offered by the mould to shrinkage.

iii) Core material and its collapsibility characteristic.

iv) Design and intricacy of the casting.

v) Casting with or without pressure, like low pressure die casting, etc.

3.2 Machining Allowance — It is the extra material added to certain parts of the castings to allow their machining or finishing to proper size. The value of the machining allowance depends on:

a) Method of casting;

b) Method of moulding (Moulding sand, etc);

c) Size and shape of casting;

d) Orientation of casting;

e) Metal characteristics;

f) Functional requirements and degree of accuracy and finish required;

g) Basic dimensions; and

h) Position of surface when pouring.

3.2.1 Machining allowances are given in Tables 2 and 2A. These values may be further modified as follows.

3.2.1.1 Actual machining allowance shall be equal to machining allowance as per Tables 2 and 2A plus pattern draft on sides or bores.

3.2.1.2 Machining allowances on bores, cutouts, curved or round surfaces shall be increased by 20 percent.

3.2.1.3 For castings where length is over 6 times the height or width, extra allowance shall be given to take care of warpage.

3.2.1.4 Machining allowance values are for guidance only. For complex castings, these shall be decided mutually between the foundry and machine shop/planning office.

3.2.1.5 This standard is not valid for the castings of non-ferrous metals cast under pressure and for the castings made of manganese alloys.

3.2.1.6 All dimensions mentioned in this standard are the dimensions prescribed in the component drawing.

3.2.2 *Terms*

3.2.2.1 *Basic dimension* — Basic dimension (Table 3) is the first dimension, determining the size of the machining allowance. It is defined by the distance of the most remote machined surface or line parallel with the surface given by the distance of two farthest opposite points on the surface to be machined. Machining allowance is decided jointly by the basic dimension and directive dimension of the casting in the plane normal to the basic dimension, for which the machining allowance is to be decided.

TABLE 2 MACHINING ALLOWANCES ON PATTERNS

(*Clauses* 3.2.1 *and* 3.2.1.1)

All dimensions in millimetres.

Basic Dimension Above	Basic Dimension Up to	Position of Surface When Pouring	Directive Dimension of Casting: Above — Up to 30	30 80	80 180	180 315	315 500	500 800	800 1 250	1 250 2 000	2 000 3 150	3 150 5 000	5 000 8 000	8 000 12 500
—	30	Upper	4·5	5 0	5·0	6·0	8·0	8·0	10·0	12·0	14·0	16·0	16·0	18·0
		Lower	3·0	3·5	3·5	4·0	5·0	5·5	7·0	8·0	9·0	10·0	11·0	11·0
30	80	Upper	4·5	5·0	6·0	6·0	8·0	9·0	10·0	12·0	14·0	16·0	16·0	18·0
		Lower	3·0	3·5	4·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0
80	180	Upper	5·0	5·0	6·0	7·0	8·0	9·0	10·0	14·0	16·0	16·0	18·0	20·0
		Lower	3·5	3·5	4·0	4·5	5·5	6·0	7·0	9·0	10·0	11·0	12·0	13·0
180	315	Upper	5·0	5·0	7·0	8·0	8·0	10·0	12·0	14·0	16·0	16·0	18·0	22·0
		Lower	3·5	3·5	4·5	5·0	5·5	7·0	8·0	9·0	10·0	11·0	12·0	14·0
315	500	Upper	5·5	6·0	7·0	8·0	9·0	10·0	12·0	16·0	16·0	18·0	20·0	24·0
		Lower	3·5	4·0	4·5	5·0	6·0	7·0	8·0	10·0	11·0	12·0	13·0	16·0
500	800	Upper	6·0	7·0	8·0	8·0	9·0	10·0	12·0	16·0	16·0	18·0	20·0	26·0
		Lower	4·0	4·5	5·0	5·5	6·0	7·0	8·0	10·0	11·0	12·0	13·0	18·0
800	1 250	Upper	7·0	8·0	8·0	9·0	10·0	12·0	14·0	16·0	18·0	20·0	22·0	28·0
		Lower	4·5	5·0	5·5	6·0	7·0	8·0	8·0	10·0	11·0	12·0	13·0	18·0
1 250	2 000	Upper	8·0	8·0	8·0	9·0	10·0	12·0	16·0	18·0	20·0	22·0	22·0	30·0
		Lower	5·0	5·0	5·5	6·0	7·0	8·0	10·0	12·0	13·0	14·0	14·0	20·0
2 000	3 150	Upper	8·0	8·0	9·0	10·0	12·0	14·0	16·0	20·0	22·0	22·0	24·0	32·0
		Lower	5·0	5·5	6·0	7·0	8·0	9·0	11·0	13·0	14·0	14·0	16·0	22·0
3 150	5 000	Upper	9·0	9·0	10·0	12·0	14·0	16·0	18·0	20·0	22·0	24·0	26·0	36·0
		Lower	6·0	6·0	7·0	8·0	9·0	10·0	12·0	13·0	14·0	16·0	18·0	24·0
5 000	8 000	Upper	10·0	10·0	12·0	14·0	16·0	16·0	20·0	22·0	24·0	26·0	30·0	38·0
		Lower	7·0	7·0	8·0	9·0	10·0	11·0	13·0	14·0	16·0	18·0	20·0	26·0
8 000	12 500	Upper	16·0	18·0	20·0	22·0	24·0	26·0	28·0	30·0	32·0	36·0	38·0	42·0
		Lower	11·0	12·0	13·0	14·0	16·0	18·0	18·0	20·0	22·0	24·0	26·0	28·0

TABLE 2A MACHINING ALLOWANCES FOR VARIOUS PRECISION DEGREES AND VARIOUS MATERIALS

(*Clauses* 3.2.1 *and* 3.2.1.1)

All dimensions in millimetres.

Sl No.	Description	Precision Degree 1		Precision Degree 2		Precision Degree 3	
		Percent Value of Table 2	Basic and Directive Dimensions	Percent Value of Table 2	Basic and Directive Dimensions	Percent Value of Table 2	Basic and Directive Dimensions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Machining allowance for steel castings	55	Consider Up to 2 000	85	Consider Up to 5 000	100	Consider Up to 12 500
2.	Machining allowance for castings of grey, spheroidal and malleable cast iron or special ferrous alloys and of non-ferrous metals	50	do	75	do	90	do

NOTE — The precision degrees shown above refer to the use of the following methods of mould production:

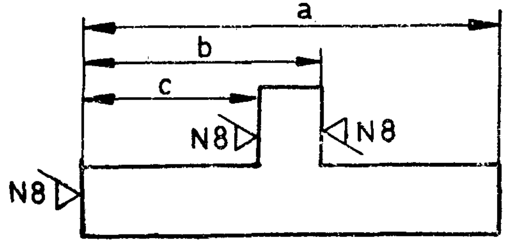
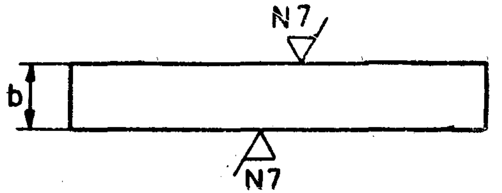
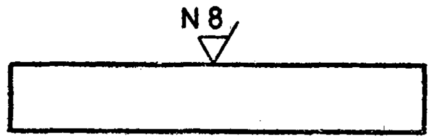
Precision degree 1 : High pressure moulding, shell, hot box or cold box moulding, moulding with organic no-bake.

Precision degree 2 : Simultaneous jolt-squeeze or squeeze type machine moulding using medium pressure, CO_2 moulding, moulding with inorganic binders.

Precision degree 3 : Green or dry sand moulding using hand or machine moulding or sand slingers, cement moulding.

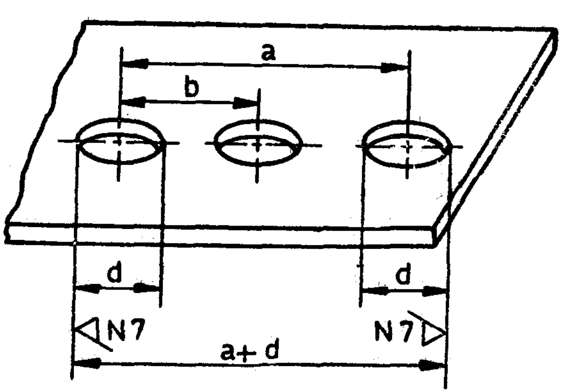
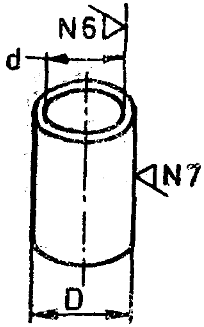
TABLE 3 EXAMPLES FOR DETERMINING THE BASIC DIMENSION

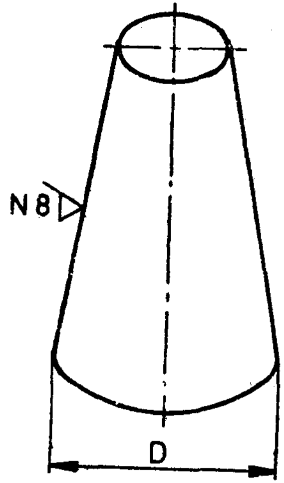
(*Clause* 3.2.2.1)

Sl No.	Drawing	Determination of the Basic Dimension	
1.		$z = b$	Basic dimension for all machined parallel plane surfaces of the casting is given by the distance of two most remote plane surfaces
2.			
3.		$z = 0$	If $z = 0$, the machining allowance is determined considering the dimension 30 mm

(*Continued*)

TABLE 3 EXAMPLES FOR DETERMINING THE BASIC DIMENSION — *Contd*

Sl No.	Drawing	Determination of the Basic Dimension
4.		$z = a + d$ Basic dimension for all the parallel machined cylindrical surfaces of the casting is given by the distance of the most remote surface. Straight lines of these surfaces
5.		$z = D$
		1·6



$z = D$ Basic dimension for conical surfaces of the casting is given by the distance of the two most remote opposite points on the surface which is being machined in the direction which is normal to the longitudinal axis

3.2.2.2 *Directive dimension* — Directive dimension is an overall dimension/largest dimension of the plane in the plane normal to the basic dimension. Basic dimension and directive dimension are jointly determining the machining allowance.

3.3 Clearance — Clearance between core and core seat on cope is provided to avoid damage of mould during core setting and closing. For drag side also to ensure easy and snug fit a small clearance is provided but only on the sides and not at bottom. Table 4 and Table 5 give the suggested values of clearances for horizontal and vertical cores respectively.

TABLE 4 CLEARANCES FOR HORIZONTAL CORES

Cope Print	Type of Mould	Clearance on Each Side, mm			
		Machine Moulding		Hand Moulding	
		Side drag	Side cope	Side drag	Side cope
10-20	Green	0·00	0·20	0·00	0·20
	Dry	0·20	0·20	0·20	0·20
21-30	Green	0·15	0·20	0·15	0·20
	Dry	0·30	0·35	0·25	0·25
31-50	Green	0·15	0·20	0·20	0·30
	Dry	0·30	0·40	0·40	0·40
51-80	Green	0·20	0·30	0·25	0·30
	Dry	0·40	0·50	0·40	0·50
81-120	Green	0·20	0·30	0·30	0·40
	Dry	0·50	0·50	0·50	0·60
121-180	Green	0·30	0·40	0·40	0·50
	Dry	0·50	0·60	0·60	0·80
181-260	Green	0·30	0·40	0·40	0·60
	Dry	0·60	0·60	0·60	0·80
261-360	Green	0·30	0·40	0·40	0·60
	Dry	0·60	0·60	0·80	1·00
361-500	Green	—	—	—	—
	Dry	0·60	0·80	0·80	0·80
501-700	Green	—	—	—	—
	Dry	0·80	0·80	0·80	1·00
701-1 500	Green	—	—	—	—
	Dry	0·80	1·00	0·80	1·00
1 501-2 500	Green	—	—	—	—
	Dry	1·00	1·50	0·10	1·50
Over 2 500	Green	—	—	—	—
	Dry	2·00	2·50	2·00	2·50

NOTE 1 — The values given in Table 7 can be taken for oil sand cores.

NOTE 2 — For shell/hot box cores, a suitable percent value can be taken.

NOTE 3 — For CO_2 and cold-set cores, a suitable percent value can be taken.

NOTE 4 — The clearances given are for uncoated core prints.

TABLE 5 CLEARANCES FOR VERTICAL CORES

(*Clause* 3.3)

All dimensions in millimetres.

Core Dia or Mean Dimension	Type of Mould	Clearance on Each Side			
		Machine Moulding		Hand Moulding	
		Drag	Cope	Drag	Cope
12-18	Green	0·00	0·10	0·00	0·00
	Dry	0·10	0·20	0·20	0·50
19-30	Green	0·00	0·20	0·20	0·25
	Dry	0·20	0·40	0·40	0·50
31-50	Green	0·15	0·30	0·30	0·40
	Dry	0·30	0·50	0·50	0·75
51-80	Green	0·20	0·30	0·40	0·50
	Dry	0·40	0·50	0·60	1·00
81-120	Green	0·20	0·30	0·50	0·60
	Dry	0·40	0·50	0·75	1·25
121-180	Green	0·20	0·40	0·50	0·75
	Dry	0·40	0·60	1·00	1·50
181-260	Green	0 30	0·50	0·60	1·00
	Dry	0·50	0·70	1·00	2·00
261-360	Green	0·40	0·50	0·75	1·00
	Dry	0·60	0·80	1·00	2·00
361-500	Green	0·40	0·60	1·00	1·50
	Dry	0·60	0·80	1·50	2·00
501-700	Green	0·50	0·70	1·00	—
	Dry	0·80	1·00	1·50	2·00
701-1 000	Green	0·80	1·00	—	—
	Dry	1·00	1·50	2·00	2·50
1 001-1 500	Green	0·80	1·50	—	—
	Dry	1·00	2·00	1·50	3·00
1 501-2 500	Green	1·00	2·00	—	—
	Dry	1·50	2·50	2·00	3·00
2 501-3 500	Green	1·50	2·50	—	—
	Dry	2·00	3·00	2·50	3·50
Above 3 500	Green	2·00	3·00	—	—
	Dry	2·50	3·50	3·00	4·00

NOTE 1 — The values given in Table 8 can be taken for oil sand cores.
NOTE 2 — For shell/hot box cores, a suitable percent value can be taken.
NOTE 3 — For CO_2/cold-set cores, a suitable percent value can be taken.
NOTE 4 — The clearances given are for uncoated core prints.

3.4 Mould Tapers — Unless otherwise specified, the mould tapers specified in Table 6 shall be adopted. Separate core prints, which are provided on the side of the pattern, have the core dimension at the lowest edge. For bigger patterns, the mould tapers shall be agreed upon between the purchaser and the manufacturer. The draft tapers on patterns and core boxes shall be so selected and specified that due to draft tapers the casting wall thickness shall not be reduced, whenever the pattern parting line is not from centre the dimensions shall be taken on the parting line and taper provided. Three systems of showing draft are shown in Fig. (a), (b) and (c) of Table 6.

3.4.1 The draft tapers on patterns and core boxes shall be specified in any one way of the ways given in Fig. (a), (b) and (c) of Table 6. The purchaser shall indicate the method to be followed. If the purchaser has not specified the method the pattern manufacturer shall ask the clarification from the purchaser before starting the manufacture.

3.5 Sand Cordon — A sand cordon is a ledge or cavity provided at the end of the lower side of the drag half of the core print in the mould in case of horizontally placed cores. Its purpose is to take up the sand flowing out during the insertion of the core in order to ensure a satisfactory core seat. The dimensions are specified in Table 7 and they shall be used according to the size of the core print.

3.6 Edge Rounding — The edges of all the surfaces with machining allowance shall be rounded, the radius of rounding being not more than 65 percent of the machining allowance, exemptions are large surfaces, which lie in the plane of the mould joint.

3.7 Permissible Variations (Tolerances) on Patterns and Core Box Dimensions — Working tolerances on pattern equipments should be unilateral. Tolerances on exterior surfaces (male portion) shall be always plus, and the tolerances on the interior or female portion of the casting will always be minus. This will provide wear allowance and will also keep the tolerances on the casting thickness towards plus side, enabling longer life of pattern till the thickness of the casting is acceptable within the permitted limits towards minus side.

3.7.1 For Class I and Class II castings (Class I and Class II tolerances of IS : 5519-1969*) male and female features will have tolerances on the untoleranced casting profile dimensions of patterns and core boxes to the following fundamental deviations and tolerances grades:

Class	*Tolerance Permitted*	
	Male	Female
I	D9	D9
II	D11	D11

*Deviations for untoleranced dimensions and mass of grey iron castings (*first revision*).

TABLE 6 TAPERS ON PATTERNS AND CORE BOXES

(*Clauses* 3.4 *and* 3.4.1)

All dimensions in millimetres.

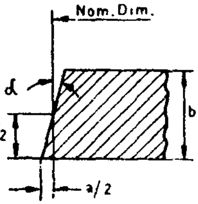


Fig. (a) Taper A

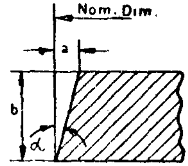


Fig. (b) Taper B

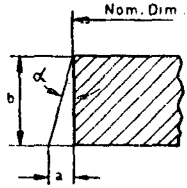


Fig. (c) Taper C

		Metals/Epoxy Patterns and Core Boxes							
		Machine Moulding				Hand Moulding			
b, mm		Nominal		Range of *a*		Nominal		Range of *a*	
Over	Up to	*a*	α	From	Up to	*a*	α	From	Up to
—	18	0·6	3°	—	0·94	0·5	5°	—	0·70
18	30	1	2°30'	0·89	1·31	1·5	3°30'	1·10	1·83
30	50	1	1°30'	0·79	1·31	1·7	2°30'	1·31	2·18
50	80	1·5	1°30'	1·31	2·10	2	2°	1·74	2·79
80	120	1·5	1°	1·40	2·10	2·5	1°30'	2·10	3·14
120	180	2	0°45'	1·57	2·36	2·5	1°	2·10	3·15
180	315	2·5	0°36'	1·89	3·31	3	1°	3·15	5·51
315	500	3	0°24'	2·20	3·50	4	0°36'	3·31	5·25
500	800	3·5	0°18'	2·50	4·16	5	0°24'	3·50	5·60

a) *Draft Angle System at Fig. (a)* — Draft is given on the casting surfaces which remain unmachined. It shall be used where design of the casting does not allow the decreases of the respective nominal dimension. In this case the on pattern and core box parting lined imensions shall be calculated and given on the pattern/corebox drawings.

b) *Draft Angle System at Fig. (b)* — Draft is given on the casting surfaces which remains unmachined and design of the casting permits decrease of respective nominal dimension and with that the weight of the casting.

c) *Draft Angle System at Fig. (c)* — Draft is given on the casting surface which (1) will be machined (2) will not be machined, but casting design permits increases of the nominal dimension.

NOTE — System of draft shall be mentioned on the drawing illustrating it by the respective figure.

The values of the tolerances are given in Table 8:

TABLE 7 DIMENSIONS OF SAND CORDON

(*Clause* 3.5; and *Table* 4)

All dimensions in millimetres.

Height (H)	3	5	10	15
Width (W)	5	10	15	20

TABLE 8 MACHINING DEVIATIONS ON UNTOLERANCED PATTERN AND CORE BOX DIMENSIONS

(*Clause* 3.7.1 and; *Table* 5)

(Deviations in µm)*

Dimension (mm)		Class I				Class II			
		Male		Female		Male		Female	
Over	Up to								
—	3	+45	+20	−20	−45	+80	+20	−20	−80
3	6	+60	+30	−30	−60	+105	+30	−30	−105
6	10	+76	+40	−40	−76	+130	+40	−40	−130
10	18	+93	+50	−50	−93	+160	+50	−50	−160
18	30	+117	+65	−65	−117	+195	+65	−65	−195
30	50	+142	+80	−80	−142	+240	+80	−80	−240
50	80	+174	+110	−110	−174	+290	+110	−110	−290
80	120	+207	+120	−120	−207	+340	+120	−120	−340
120	180	+245	+145	−145	−245	+395	+145	−145	−395
180	250	+285	+170	−170	−285	+460	+170	−170	−460
250	315	+320	+190	−190	−320	+510	+190	−190	−510
315	400	+350	+210	−210	−350	+570	+210	−210	−570
400	500	+385	+230	−230	−385	+630	+230	−230	−630
500	630	+435	+260	−260	−435	+700	+260	−260	−700
630	800	+490	+290	−290	−490	+790	+290	−290	−790
800	1 000	+550	+320	−320	−550	+880	+320	−320	−880
1 000	1 250	+610	+350	−350	−610	+1 010	+350	−350	−1 010
1 250	1 600	+700	+390	−390	−700	+1 170	+390	−390	−1 170
1 600	2 000	+800	+430	−430	−800	+1 350	+430	−430	−1 350
2 000	2 500	+920	+480	−480	−920	+1 580	+480	−480	−1 580
2 500	3 150	+1 060	+520	−520	−1 060	+1 870	+520	−520	−1 870

*1 µm (micrometre) = 0·001 mm = 1 micron.

3.8 Cored Holes — Holes in rough casting generally need not be produced as-cast if with steel castings

$$d \nless 0{\cdot}4\,h + 10$$

and with castings of grey iron, SG iron and malleable cast iron, special ferrous alloys and non-ferrous metals there is

$$d \nless 0{\cdot}3\,h + 10$$

where

d is the diameter of the hole in mm, and

h is depth of hole in mm.

In cases when economical advantage is evident and following an agreement between the supplier and the purchaser, holes of smaller diameters may also be produced as-cast.

3.9 Core Print Dimensions

3.9.1 *Horizontal Core*

3.9.1.1 *Supported on both sides* — Horizontal core print dimension supported on both sides shall be as shown in Fig. 1.

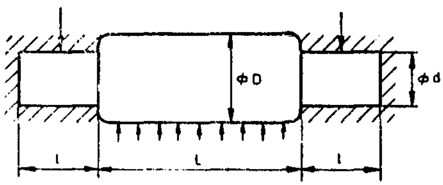


FIG. 1 CORE SUPPORTED ON BOTH SIDES

Allowable stress : For green sand : $P_a = 0{\cdot}5$ kg/cm²

For dry sand : $P_a = 2{\cdot}5$ kg/cm²

$$P_a = \frac{P}{2.\,dl} \qquad \text{(i)}$$

$$P = \frac{\pi D^2 L}{4} \times (\text{Molten metal density} - \text{Core density}) \qquad \text{(ii)}$$

Using (i) and (ii) needs a relation between l and d of the core print, the following values can be taken for guidance:

for d = 200 mm	l/d = 0·25-1·0
d = 201 to 400	l/d = 0·25-0·75
d = 401 to 1 000	l/d = 0·2-0·5
d = 1 001 and above	l/d = 0·15-0·3

3.9.1.2 *Cores supported on one side*

For D or H 150 mm, $l = 1{\cdot}25\ L$, $D = d$ or $H = h$

D or H 150 $l = L$, $d = 1{\cdot}5$ to $1{\cdot}8\ D$ or $h = 1{\cdot}5$ to $1{\cdot}8\ H$

D = Diameter of core, H = Height of core [*see* Fig. 2(a) to 2(c)],

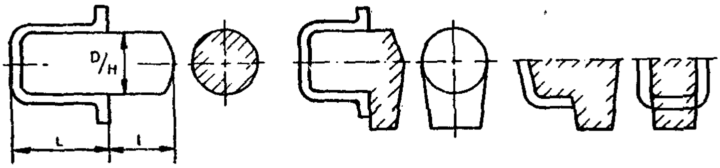
d = Diameter of core print, h = Height of core print, and

l = Length of core print.

Table 9 gives dimensions of core prints for various core sizes, for core length beyond 1 500, core grid (reinforcements) dimensions are to be taken care of.

TABLE 9 CORE PRINT DIMENSIONS

Core Length mm	Type of Mould	Length of Core Print in mm for Various Diameters of Cores or Dia of Circumscribing Circle									
		00-50	51-100	101-160	161-250	251-400	401-650	651-1 000	1 001-1 600	1 601-2 500	Above 2 500
Up to 50	Green	20	25	30	35						
	Dry	20	25	30	35						
51-100	Green	30	35	40	45	50					
	Dry	30	35	40	45	50					
101-200	Green	35	40	50	60	90					
	Dry	35	40	50	60	75					
201-400	Green	40	50	70	110	180					
	Dry	40	50	60	65	90	110	130			
401-700	Green		80	125	190						
	Dry		60	75	90	110	130	155	180		
701- 1200	Green			135	220						
	Dry			90	110	130	155	180	220	250	
1 201-2 000	Green				130	155	180	220	250	300	350
	Dry										
2 001-3 000	Green					180	220	250	300	350	400
	Dry										
Above 3 000	Green						250	300	350	400	500
	Dry										



(a) (b) (c)

FIG. 2(a) CORE SUPPORTED AT ONE END

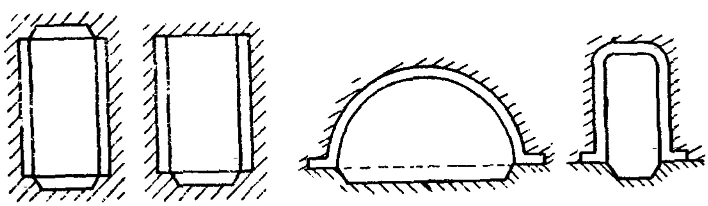
FIG. 2(b) and 2(c) ARRANGEMENTS FOR PREVENTING THE CORE FROM ROTATION

Cores supported on one print shall be used in cases where $L \ngtr 1, 2D$ or $L \ngtr 2H$. Fig. 2(a).

If $L > 1, 2D$ or $1, 2H$, other arrangements as indicated in (b) and (c) shall have to be made to prevent the core displacement, both due to its own mass and due to the upward thrust of the metal.

3.9.2 *Vertical Cores* — (i) Cores secured at both ends. Shall be shown in Fig. 3(a).

(ii) Cores secured at one ends. Shall be shown in Fig. 3(b), (c) and (d).



(a) (b) (c) (d)

FIG. 3 VARIOUS TYPES OF VERTICAL CORES

3.9.2.1 A rough guidance to determine whether the core needs a top print or not is given below:

Only bottom core print is necessary when following conditions are fulfilled:

$d < 250$ mm, $H/d < 3{\cdot}0$

$d = 251\text{-}400$ mm, $H/d \leqslant 2{\cdot}5$

$d = 401\text{-}650$ mm, $H/d < 2{\cdot}0$

If d or $\frac{l+b}{2}$ is exceeding these values, it is either necessary to use top print or deepen the bottom print to ensure stability of the core. The height of the top core print shall be about ½ that of bottom print. However, if both top and bottom prints are provided even when the values of d or $\frac{l+b}{2}$ do not exceed the suggested values, it is possible to reduce the bottom core print correspondingly. Dimensions of vertical core prints are given in Table 10. Taper on core prints is given in Table 11.

TABLE 10 VERTICAL CORE PRINTS

All dimensions in millimetres.

Height of Core mm	Diameter of Core 'd' or $\frac{l+b}{2}$									
	Up to 50	51-100	101-160	161-250	251-400	401-650	651-1 000	1 001-1 600	1 601-2 500	Above 2 500
Up to 50	30	30	30	30	30					
51-100	30	30	40	40	50	50				
101-200	40	50	50	60	60	60	80			
201-400	50	60	60	70	70	70	90	100	110	
401-700	60	70	70	80	80	80	100	110	120	140
701-1 200	—	90	100	100	110	110	130	140	150	170
1 201-2 000	—	—	130	130	140	140	150	160	170	190
2 001-3 000	—	—	—	160	170	170	180	190	200	220
Above 3 000	—	—	—	—	200	200	210	220	230	250

3.10 Crush Strip — Crush strip is a small continuous projection made at the periphery of the pattern as shown in Fig. 4.

TABLE 11 TAPERS ON CORE PRINT

(*Clause* 3.9.2.1)

Core Diameter or Core Mean Dimension (mm)		Height of Core Prints (in mm)													
		Drag							Cope						
		Above — Up to 10	10 18	18 30	30 80	80 180	180 315	315 500	Above — Up to 10	10 18	18 30	30 80	80 180	180 315	315 500
Above	Up to														
—	18	3°	3°	3°					8°	8°					
18	30		3°	3°					8°	8°	8°				
30	80			3°	3°				10°	15°	15°				
80	180				5°	3°				10°	15°	10°			
180	315				5°	3°					15°	10°			
315	500				5°	5°	3°					15°	10°		
500	800				5°	5°	3°					15°	10°		
800	1 250					5°	3°	3°				15°	10°		
1 250	2 000						3°	3°					15°	10°	—

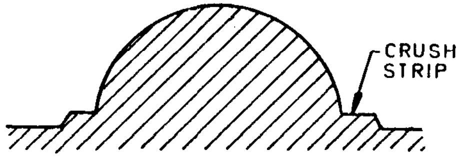


FIG. 4 CRUSH STRIP

It is provided to protect the edge of the moulds while closing and thereby preventing sand falling into mould cavity. Width and thickness of crush strip depends upon the pattern size. Usually 10 × 1 mm strip will be sufficient, wherever crush strips are not provided a minimum fillet radius of 1 to 1·5 mm is to be provided at the corners between pattern and match plate.

3.11 Jolt Strip or Wear Strip — Jolt strip or wear strip is provided on match plate to have perfect sealing of mould while closing [*see* Fig. 5(a) and 5(b)]. Usually 30 × 6 mm MS or case hardened steel as agreed to between the purchaser and the supplier are fixed on match plates. Wear strip surface should be flat and 0·4 to 1 mm above match plate surface. The surface of the moulding box edge which is seating on the wear strip also should be smooth and variations on flatness should be less than half of that of the gap between wear strip and match plate.

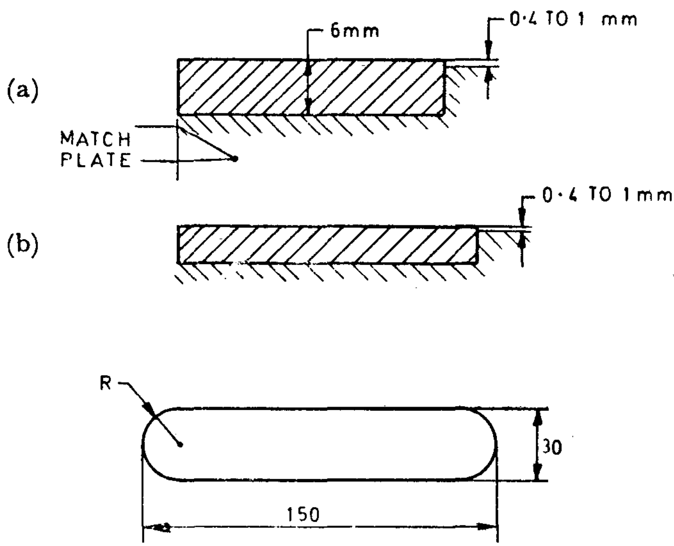


FIG. 5 JOLT STRIP OR WEAR STRIP

4. FASTENERS

4.1 Fasteners covered by IS : 1367* (published in several parts) shall be used.

5. EPOXY RESIN PATTERNS

5.1 Epoxy resin patterns and core boxes (with cast aluminium alloy frame) are suitable where production quantities are large and wooden patterns are totally inadequate. They have high strength to mass ratio (above 5·2 as compared to 4·5 for aluminium and 2·8 for cast iron), possess good resistance to wear and abrasion and are free from warpage.

5.2 The resin-mix consists of a liquid cold setting epoxy resin and a chemical hardener. Usually a gel-coat resin mix is first used to form the hard, wear resisting surface of the pattern. It is backed by a toughening material like woven glass fibre-soaked in a laminating resin mix. These laminations are backed finally by a casting resin mix which is also mixed with a filler like talc powder, slate powder or silica flour. Once fully hardened which takes about 24 hours, pattern is ready for use and requires no machining. Resin ingredients and type shall be decided as per the recommendation of resin manufacturer.

5.3 Epoxy patterns are usually employed for match plate work and machine moulding.

6. LIFE EXPECTANCY

6.1 Life Expectancy of Epoxy Pattern and Core Boxes — Life expectancy of epoxy pattern and core boxes shall be as given in Table 12.

TABLE 12 LIFE EXPECTANCY OF EPOXY PATTERN AND CORE BOXES

Method of Production	Pattern Material	Required Construction	Life in Number of Moulds/Cores
Loose	Epoxy plastic	Cast in plaster or plastic moulds using casting resin only	Limited production
Mounted	Epoxy plastic and filler material	Cast in plaster, metal or plastic moulds using gel-coat, lamination and casting resin	5 000
Mounted, fibreglass reinforcement (pattern)	Epoxy plastic, filler material and metal reinforcement	Using gel-coat, lamination and casting resin with filler material and reinforcement as necessary. Lamination with minimum 2 layers of fine woven glass fibre cloth	Over 5 000
Epoxy core box made over aluminium (Grade 4600-M to IS : 617-1975*)	do	Minimum wall thickness 8 mm	5 000

*Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes (*second revision*).

*Technical supply conditions for threaded steel fasteners.

6.2 Life Expectancy of Metal Pattern and Core Boxes — Life expectancy of metal pattern and core boxes shall be as given in Table 13.

TABLE 13 LIFE EXPECTANCY OF METAL PATTERN AND CORE BOXES

Method of Production	Pattern Material	Required Construction	Life in Number of Moulds/Cores *Min*
Patterns:			
Mounted	Pressure cast aluminium	As cast and cleaned	3 000
Mounted	Sand cast aluminium, brass	As cast and cleaned	5 000
Mounted	Sand cast aluminium, brass, SG iron, grey iron, steel	Machined and all machine marks removed and polished for higher precision	30 000
Core Boxes:			
Hand ram, or blowing	Pressure cast aluminium	As cast and cleaned	3 000
Hand ram, or blowing or hot box	Sand cast aluminium, brass	As cast and cleaned	5 000
Hand ram, blowing or hot box	Sand cast aluminium, brass, cast iron (grey iron and SG iron), steel forgings	Machined and all machine marks removed, polished for higher precision	30 000 ———— 50 000

(*Continued from page* 2)

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